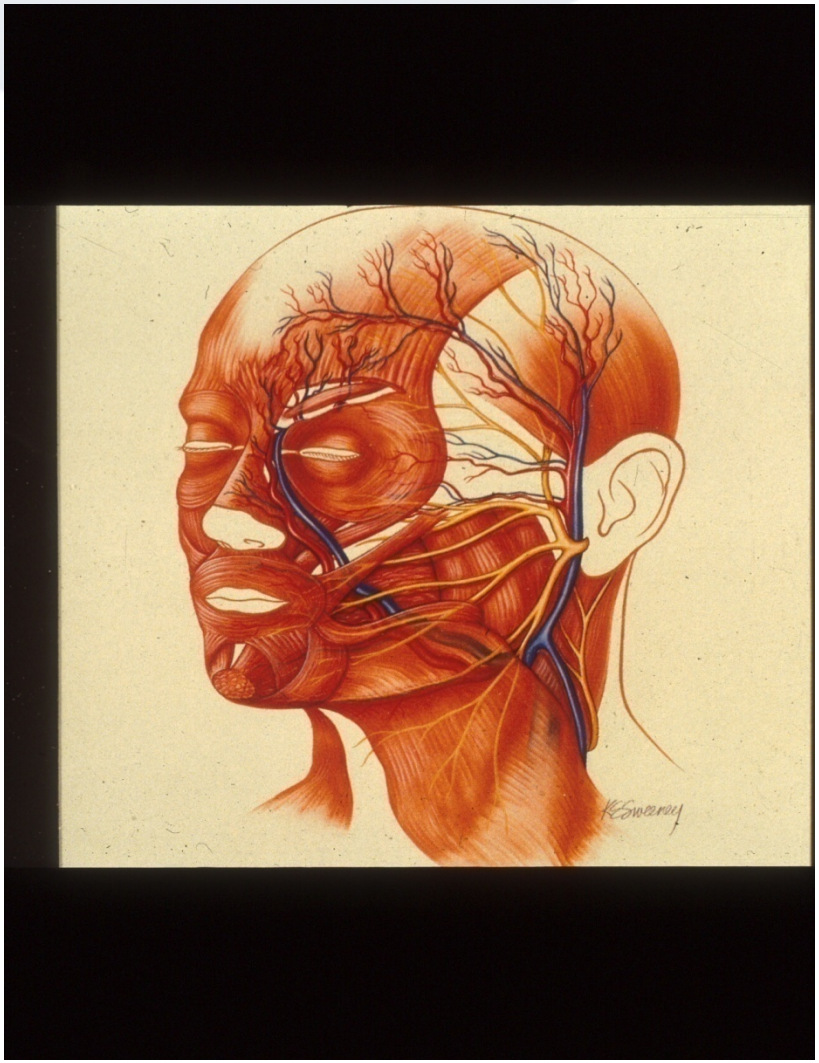
Electroneuronography (ENoG)



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Douglas L. Beck Au.D.
Director of Professional Relations
Oticon Inc
Somerset, NJ 08873
Ph – 1-800-526-3921
E-mail dmb@oticonusa.com
www.oticonusa.com

James W. Hall III, Ph.D.
Clinical Professor
Department of Speech, Language & Hearing Sciences
College of Public Health and Health Professions
University of Florida
Gainesville, Florida
Jwhall3@phhp.ufl.edu

ENoG: Presentation Overview

- ❑ Etiologies
- ❑ Alternative facial nerve tests
- ❑ Facial nerve anatomy
- ❑ Facial nerve physiology
- ❑ Bell's Palsy
- ❑ H-B Facial Grading System
- ❑ Stimulation Techniques
- ❑ Recording Techniques
- ❑ Interpretation & reporting guidelines.

Facial Nerve Paralysis

Facial nerve paralysis is absolutely debilitating.

Primary debilitation involves emotional and psychological impact of facial disfiguration. Socialization and community participation is extraordinarily limited and difficult for many of these patients.

Secondary debilitation involves physical limitations, difficulties speaking, drinking, eating and facial expression.

Facial Nerve Disorders: Possible Etiologies

- Mumps
- Chicken-pox
- Gilllain-Barre syndrome
- Central nervous system disorders (i.e., stroke)
- Glomus jugulare
- Meningioma
- Facial nerve neuroma
- Trauma

Facial Nerve Disorders: Etiologies cont'd…

- Bell's Palsy (more on this in a moment)
- Iatrogenic (surgically induced)
- Temporal bone trauma secondary to MVA
- Otitis media
- Herpes zoster oticus
- Multiple sclerosis
- Melkersson-Rosenthal syndrome
- Mastoiditis

Other facial nerve tests:

- Hilger test
- Electromyography (polyphasic APs…)
- Acoustic reflex testing
- Antidromic nerve potentials
- MRI and CT
- Maximal/minimal nerve stimulation tests
- Transcranial magnetic stimulation
- Blink reflex tests
- Others….

The Essence of ENoG….

ENoG is the electrical stimulation of the facial nerve at (or near) the stylomastoid foramen (SMF) with measurements taken from the nasio-labial fold.

ENoG is the only "relatively objective" measure of facial nerve integrity.

ENoG compares the normal side to the abnormal side to quantify and prognosticate.

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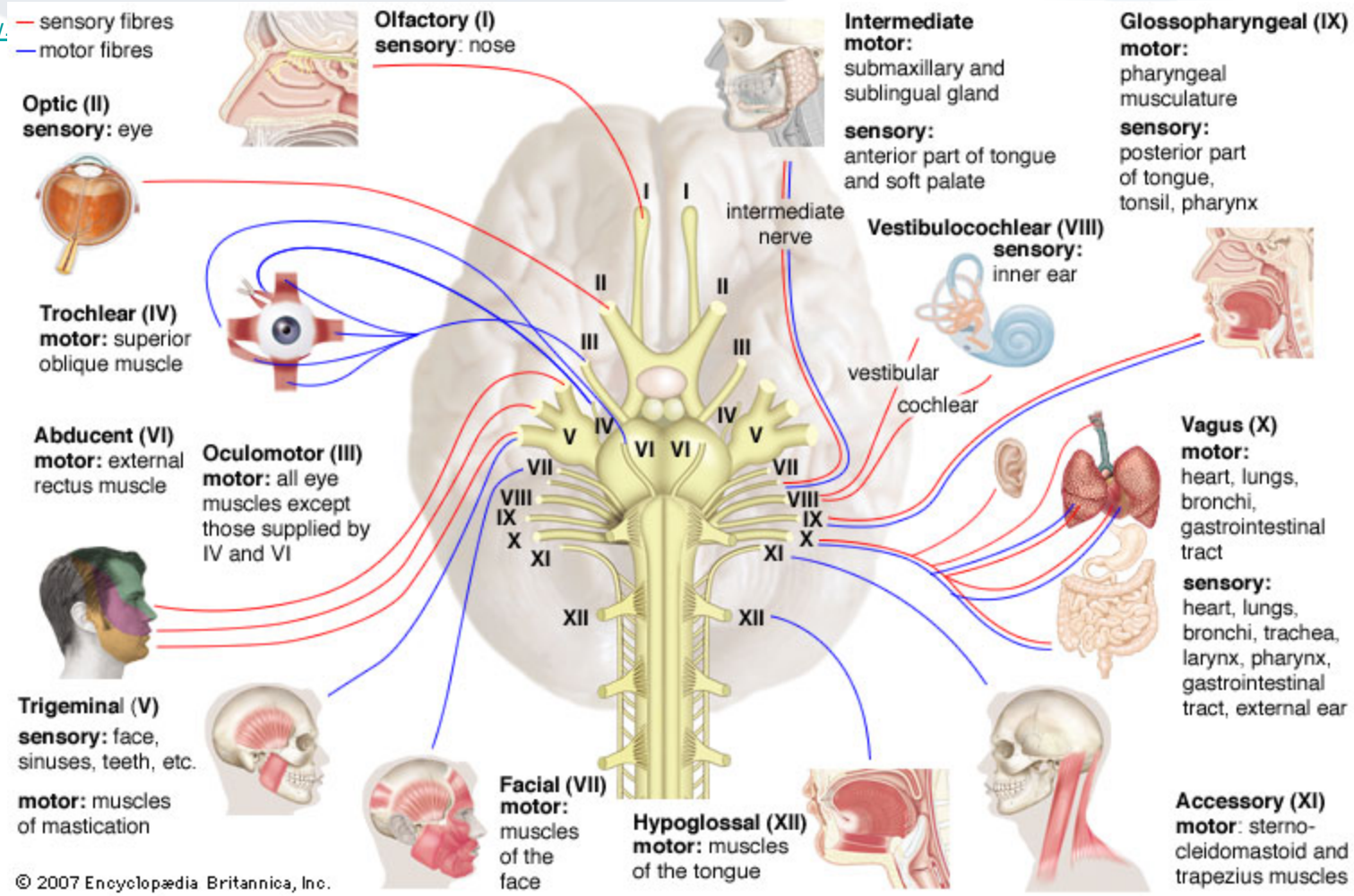
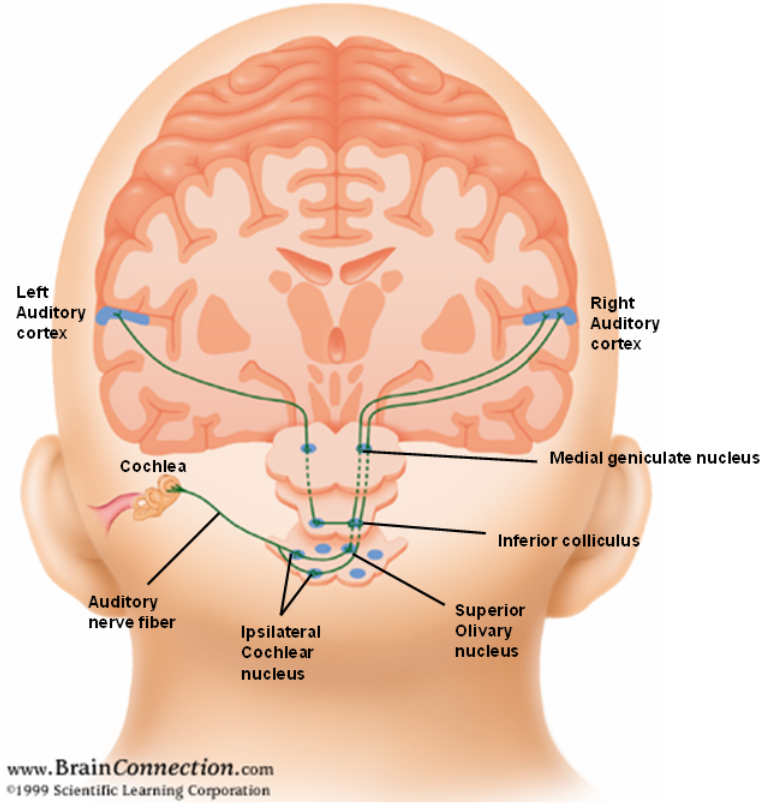
Cranial nerve innervation

http://www.



VII & VIII travel together…from brainstem to distal end of the IAC…



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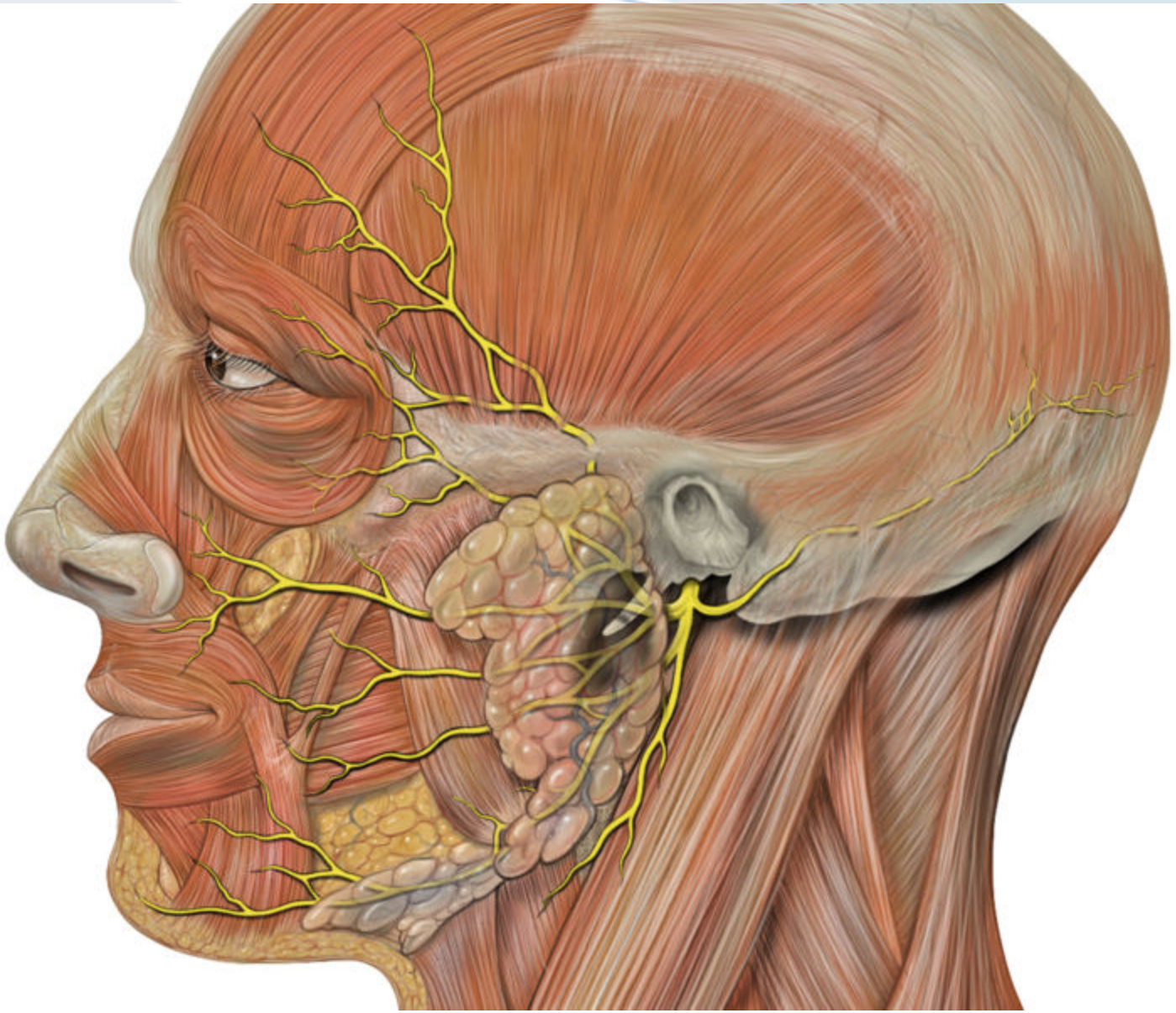


Facial Nerve Anatomy…

Facial Nerve (cn VII) has 10,000 fibers (2/3rds motor, 1/3rd sensory)

Normal facial motion requires only half the motor fibers.

Facial Nerve Anatomy …

Facial nerve has five landmark segments:

1) labyrinthine

2) tympanic

3) pyramida

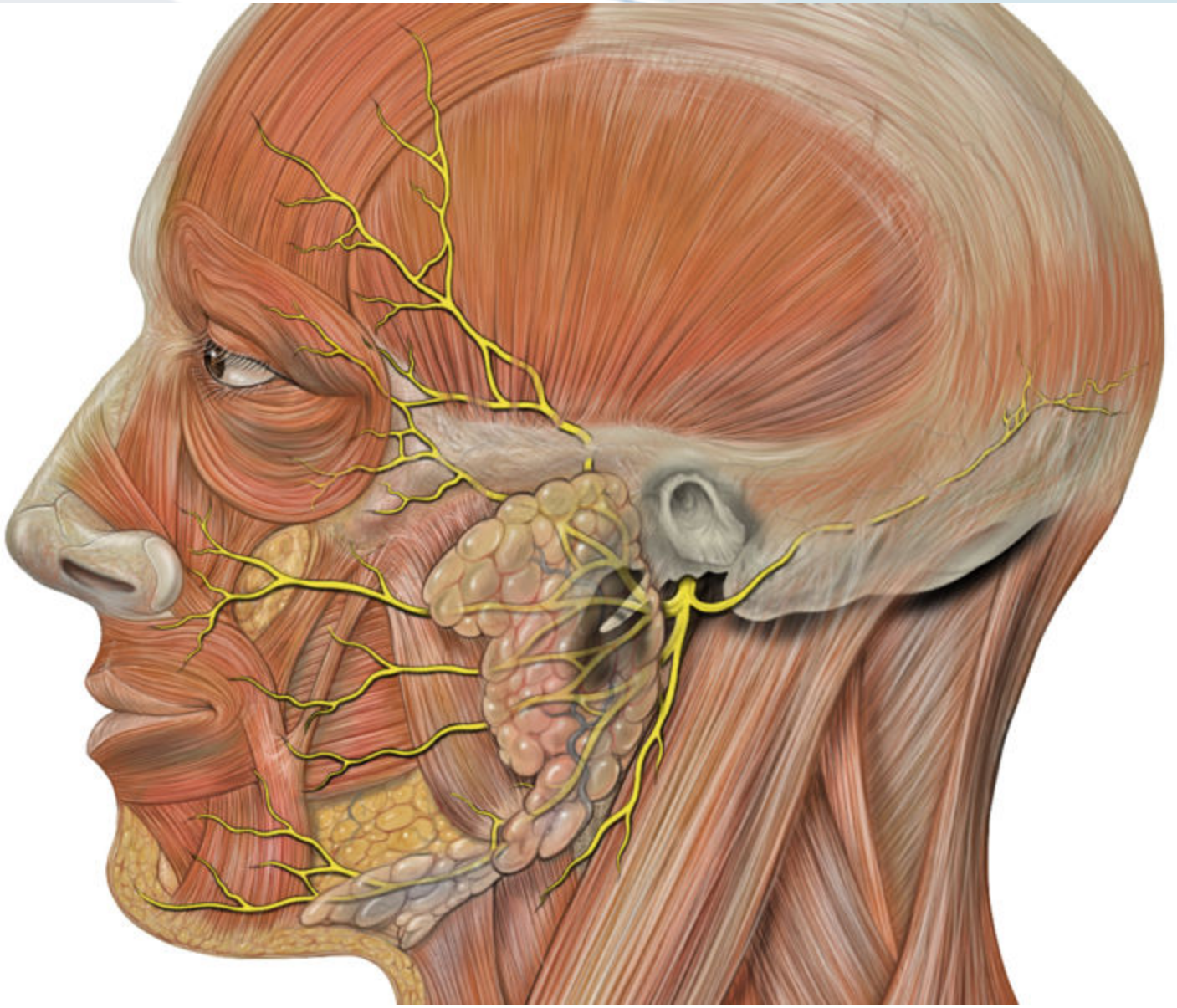
4) mastoid

5) stylomastoid foramen (SMF)

The facial nerve emerges from SMF, enters parotid gland and divides:

1) Superior division (temporal, zygomatic, buccal)

2) Inferior division (buccal, mandibular, cervical)



3 Types of Facial Nerve Injury:

Neuropraxia: Most common finding with BP. Paralysis without peripheral nerve degeneration. ENoG is normal or reduced response, nerve fibers and sheath are intact, but not responsive to volitional commands.

Neurotmesis: Worst possible outcome. ENoG no response (i.e. flat line). Total anatomic separation, very poor prognosis

Axnotmesis: Inner nerve fiber disruption with intact outer casing (epineurium). ENoG no response (i.e., flat line).

(ENoG cannot differentiate neurotmesis from axonotmesis)

Bell's Palsy Overview:

Facial muscles weak or non-responsive.

Caused by injury to the 7th cranial nerve.

Sir Charles Bell, Scotland, 200 years ago.

Worldwide incidence 0.02%:
1 in 5000 people worldwide,
40,000 in the USA annually.

Left/right, Male/female, race, L and R sides equal.

Older people more likely, children are possible.

Diabetics four times more likely than non-diabetes

Last trimester of pregnancy higher risk for BP.

HIV & Sarcoidosis increase the odds of acquiring BP
(Sarcoidosis is an inflammation, produces microscopic granulomas)

BP Overview cont'd…

Both sides simultaneously, rare (less than 1 %)

Does not affect other body systems.

BP is often noticed first thing in the AM…

Early symptoms (dry eye, tingling mouth/lips, weak mouth (slurping). May take a day or two to fully engage.

BP usually "peaks" within 72 to 96 hours.

BP is not contagious.

Recovery: 50% complete recovery in 4 to 8 weeks.
35% recover in less than a year.

Recurrence: 8 percent recur, may take ten years until 2nd event.

BP Treatment Options:

- ❑ Surgical intervention
- ❑ Wait and watch approaches
- ❑ Medical management
  - ✓ Acyclovir
  - ✓ Steroids…
- ❑ Eye care:
  - ✓ Patch
  - ✓ Tape
  - ✓ Shades
  - ✓ Artificial tears….

House-Brackmann (HB) Facial Grading Scale:

HB scale approximates quantity of volitional motion based on clinical facial presentation.

HB grossly describes characteristics and degree of facial nerve motion using subjective analysis.

HB scale has six grades, each grade is reported as a fraction.

House-Brackmann Facial Grading

Grade one (1/6): normal

Grade two (2/6): slight/mild weakness

Grade three (3/6): moderate weakness with normal eye closure

Grade four (4/6): moderate weakness without eye closure

Grade five (5/6): severe weakness

Grade six (6/6): total facial paralysis

When to test?
Which question are we answering….

Consider, only grade six (6/6) presentations *require*

EnoG testing, if the purpose is to determine whether the facial nerve is intact. If we're "tracking" the progress of function or dysfunction,

ENoG can be used to monitor progress.

Difficult to discern 5/6 from 6/6 due to masseter or contralateral pull

Wallerian Degeneration:

Wallerian Degeneration (WD) takes approximately 72 hrs for *denervation* to completely impact neural fibers.

If you test HB 6/6 facial one hour post-onset BP, the likely result is a normal ENoG because neural fibers are physiologically intact, although non-functional volitionally, yields "false negative" test.

Wait 72 hours before first ENoG to allow complete WD.

WD occurs proximal to distal to damage in CNS and PNS.

Timing the ENoG Test:

ENoG "valid" from 3 to 21 days.

1st test 72 hrs post-onset, retest 3 to 5 day intervals.

No guidelines after 21 days….

Surgical Management of BP
Laryngoscope 109(8), August 1999, Gantz, Rubinstein, Gidley & Woodworth

54 subjects < 90% denervation all returned to HB grade I or II within 7 months post-onset.

19 subjects >90% denervation, with no f.n. decompression
58% chance of outcome HB grade III or IV at 7 mos post-onset.

31 subjects >90% denervation, with f.n. decompression
91% chance of HB grade I or II.

ENoG:
Stimulus Parameters

Transducer:	**Pair of electrodes**
Site:	**Stylomastoid foramen**
Orientation:	**anode (+) anterior (“black back”)**
Type:	**Constant current pulse**
Mode:	**Continuous**
Duration:	**0.2 ms (200 microseconds)**
Rate:	**1.1/sec**
Laterality:	**Unilateral (uninvolved side first)**
Intensity:	**To produce supra-maximal response (usually > 10 mA)**

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ENoG:
Acquisition Parameters

Analysis time:	**20 ms**
Filter settings:	**3 to 3000 Hz**
Notch filter:	**No**
Amplification:	**X 5000 or less**
Electrodes:	**Ipsilateral nasolabial fold (ground on forehead)**
Impedance:	**< 5K ohms**
Sweeps:	**1 to 20**

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Electroneuronograpy (ENoG): Principles

Patients motivated to find a definitive diagnosis

They will tolerate some discomfort to reach the diagnosis.

Fully explain ENoG procedure, avoiding terms that will cause alarm or concern.

Possible explanations for a “sub-optimal” response should be explored and resolved with trouble-shooting and modification of the technique.

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ENoG Principles (continued)…

Evoke optimal ("supra-maximal") distal facial nerve EMG from each side w/same stimulation and recording technique

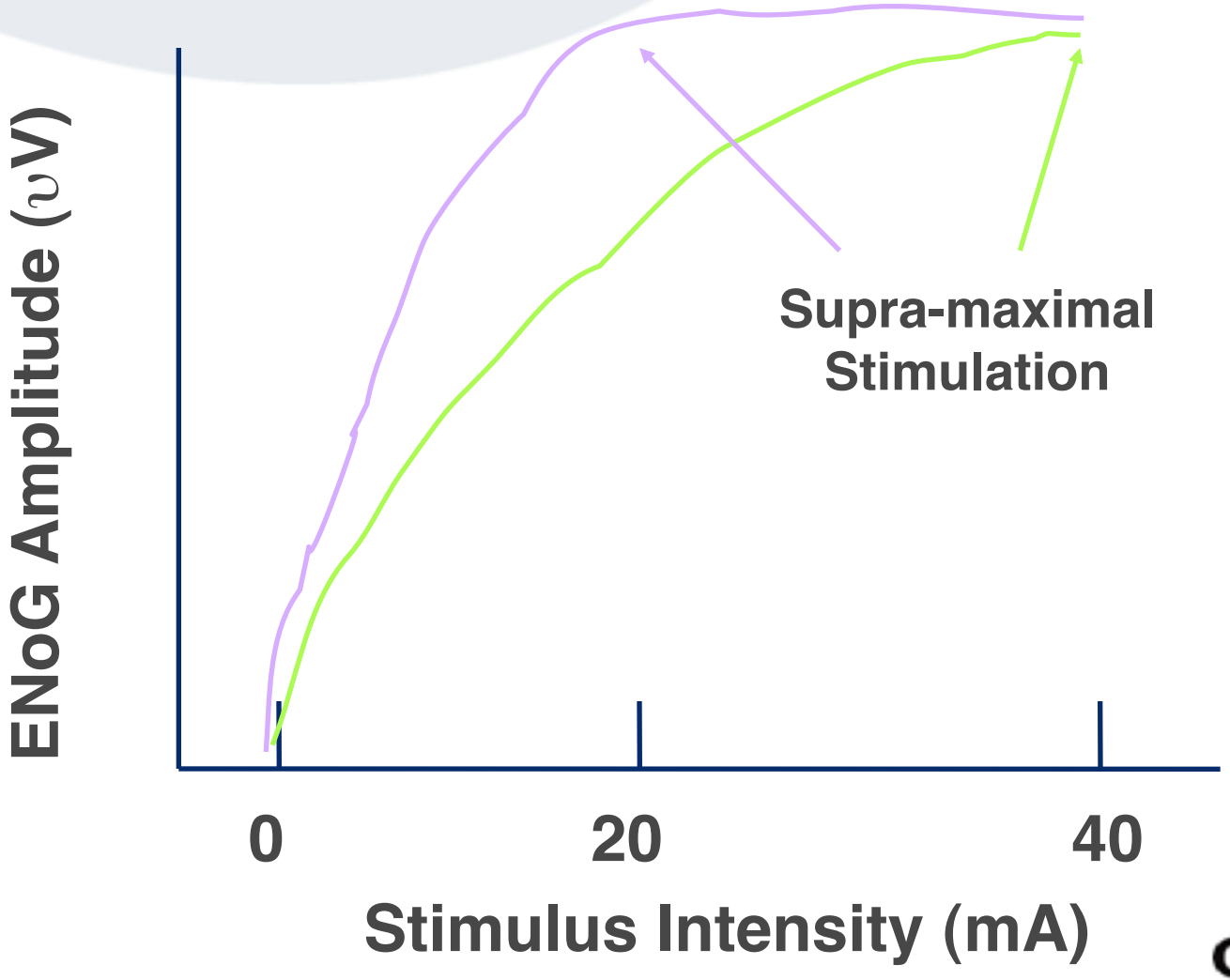
Analyze "bad" relative to "good" side.

Amplitude matters, not latency.

If "bad" side <10% of good side, significant degeneration has occurred, surgical intervention is an option.

If "bad" side >10%, possible spontaneous recovery … "watch & wait".

ENoG Stimulus Parameters: Supramaximal Stimulation



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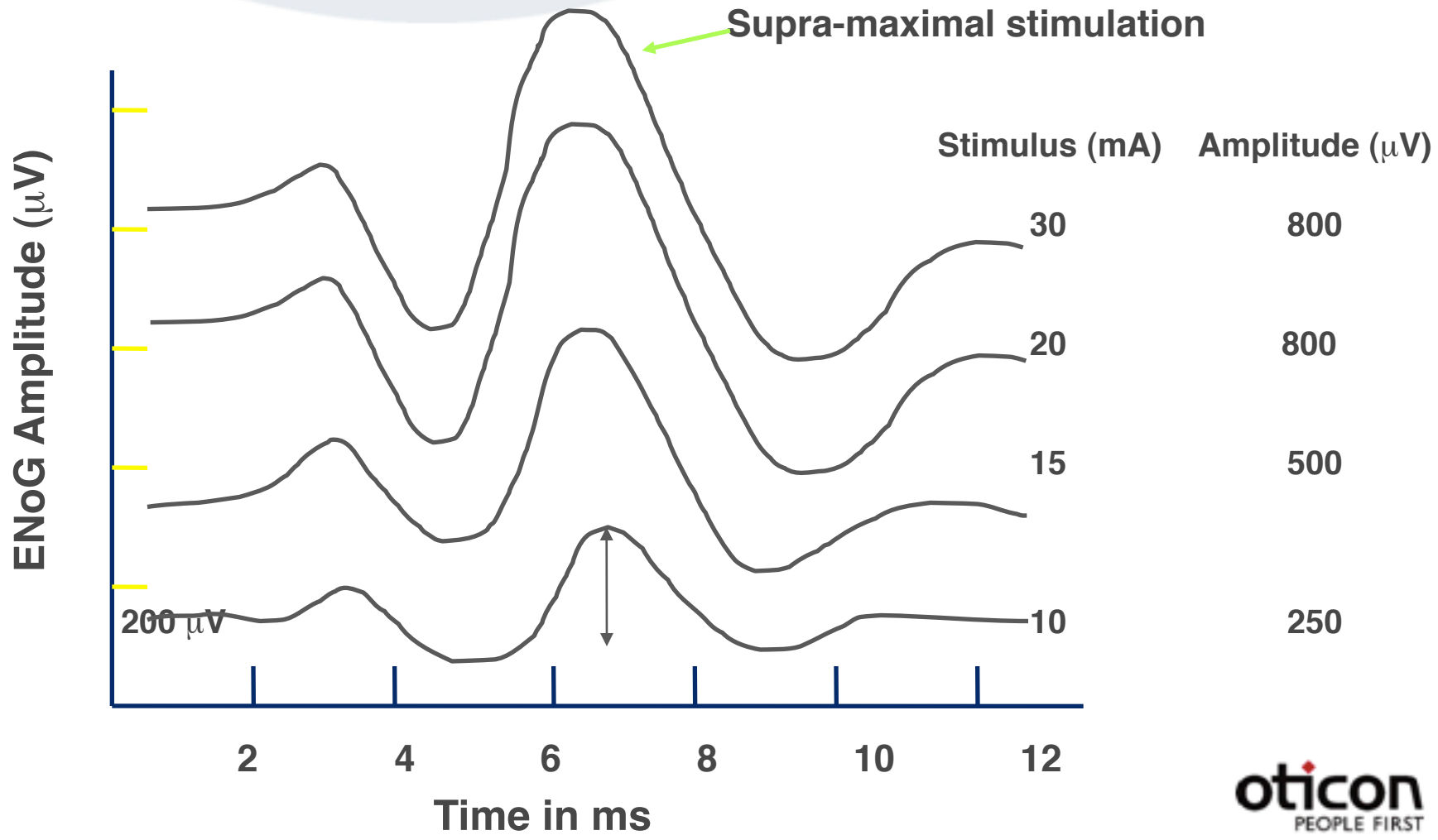
ENoG:
Concept of Supra-Maximal Stimulation



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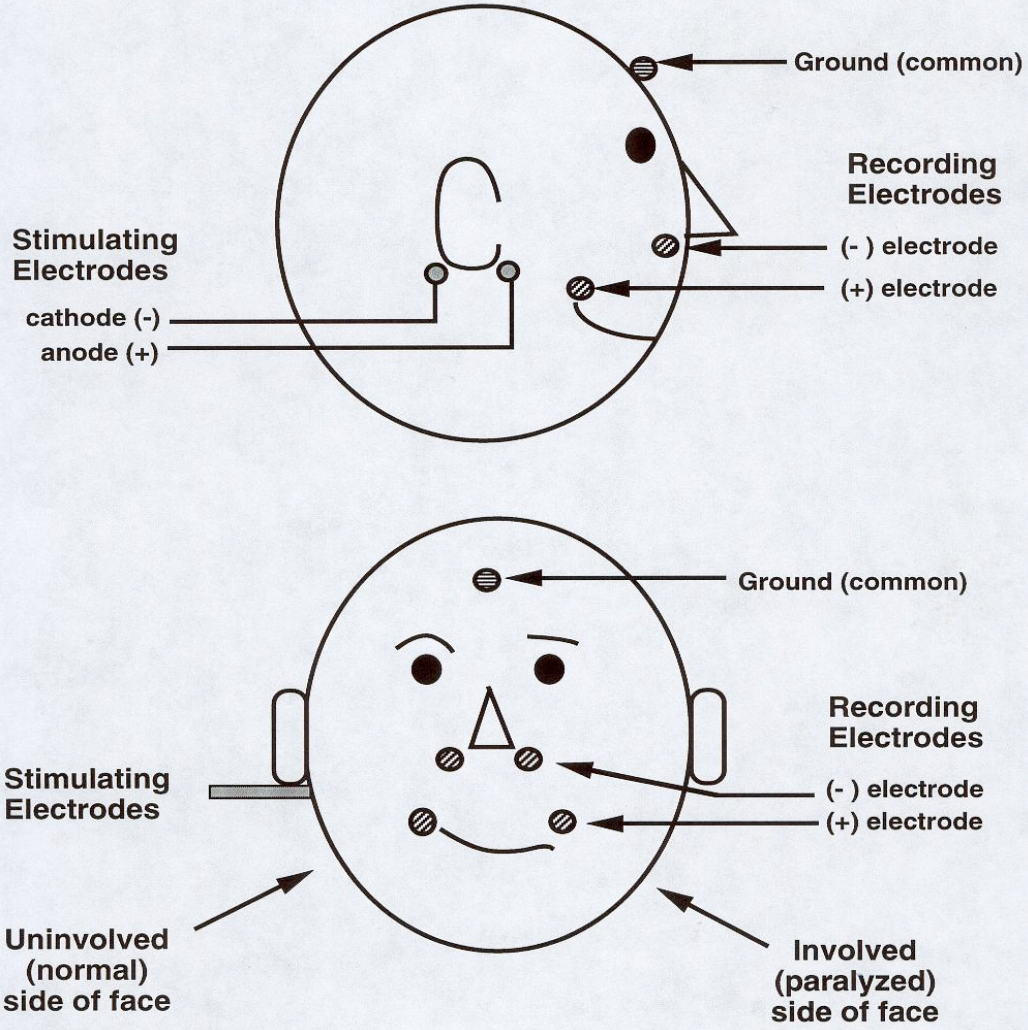
ELECTRONEURONOGRAPHY (ENoG)

Stimulating and Recording Electrode Sites



TIP: test this side first and use ENoG values as a reference

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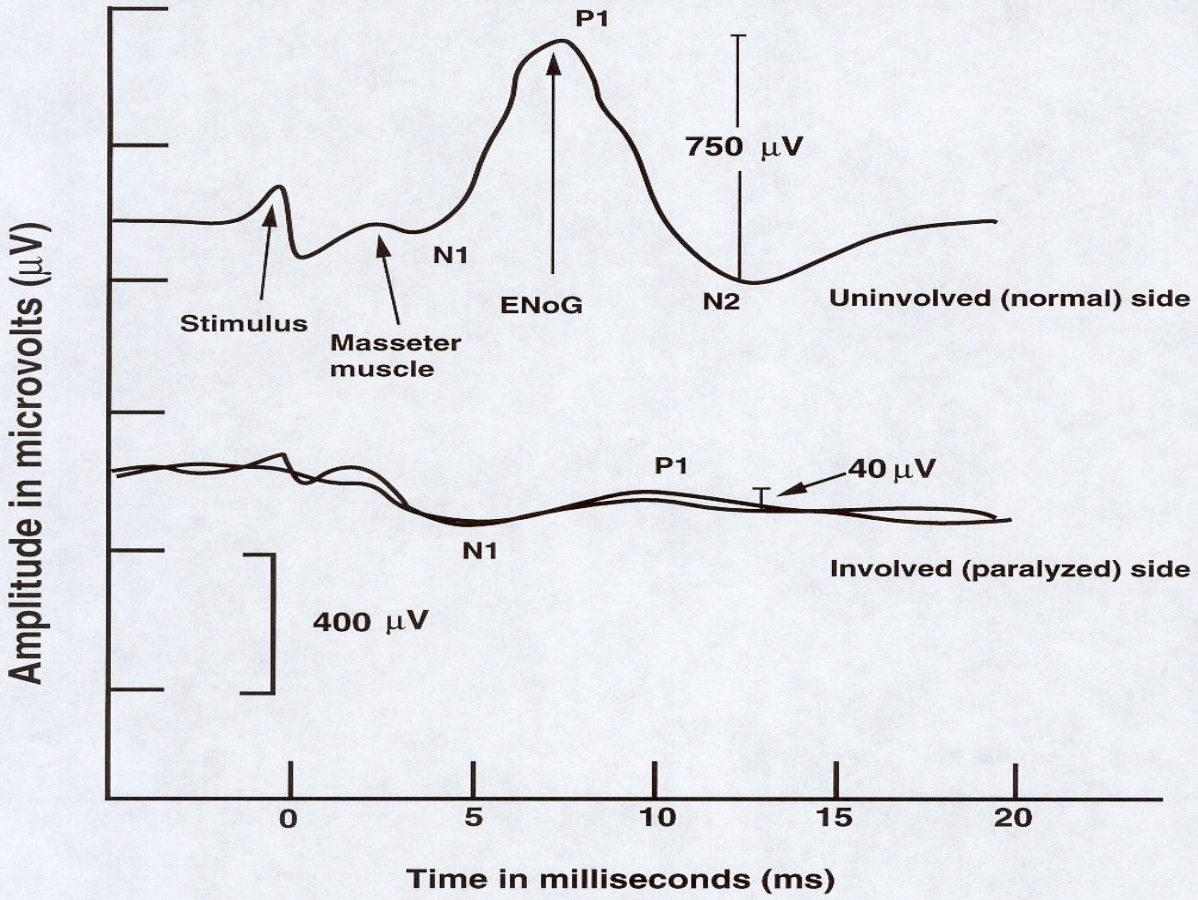
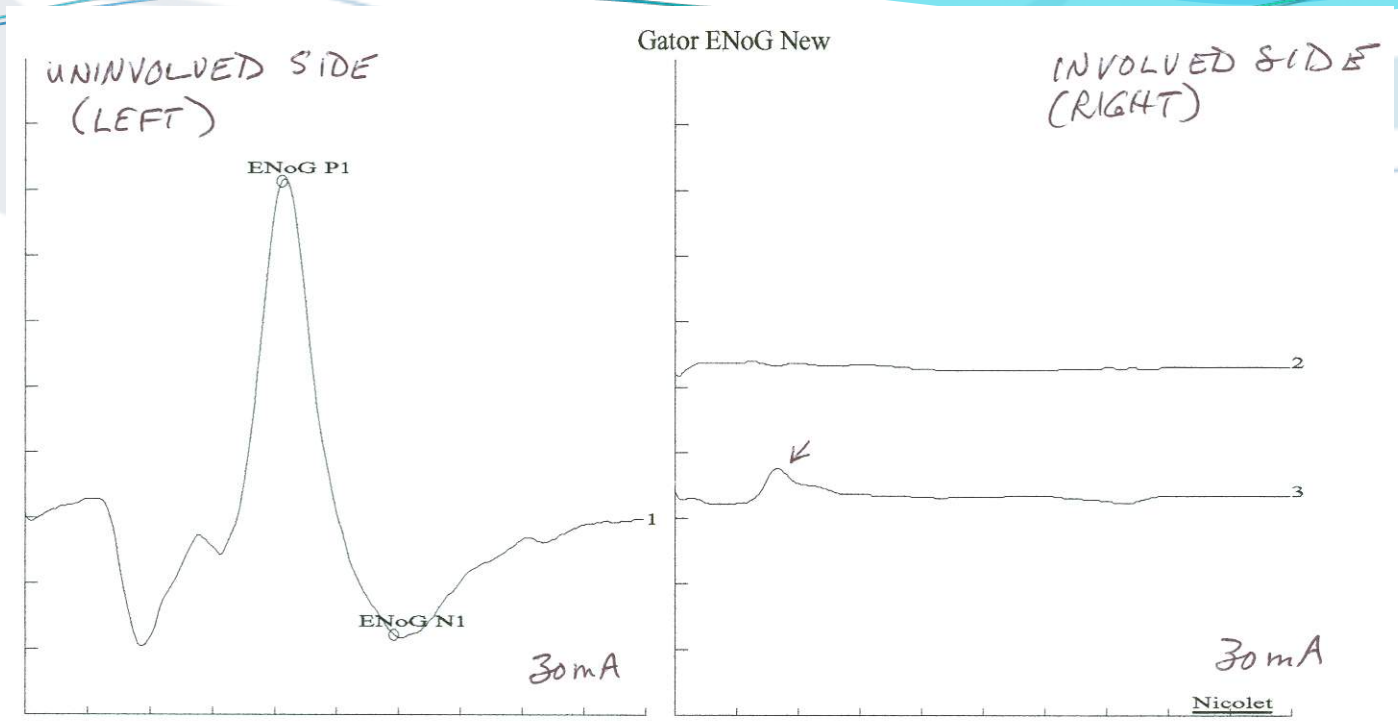
Electroneuronography (ENoG) Analysis:

Analysis: "Significant degeneration in facial nerve response"



$$\text{Percent degeneration} = 100 - \frac{\text{amplitude on involved side of face } (\mu V)}{\text{amplitude on uninvolved side of face } (\mu V)} \times 100$$

$$\text{Percent degeneration} = 100 - \frac{40\ \mu V}{750\ \mu V} \times 100 = 95\%$$



Sensitivity and Sweep Time Per Division

1	250.00 uV	2.0 msec	2	250.00 uV 2.0 msec	3 250.00 uV 2.0 msec

ENoG

ENoG N1	12.84ms	ENoG Amp
ENoG P1	9.24ms	
ENoG N1		
ENoG P2		

ENoG Recording: Trouble Shooting

Symptom:	**No response bilaterally**
Problems:	**Chemical paralysis (in the O.R. or ICU)** **Improper electrode placement** **Electrical failure**
Solutions:	**Reverse neuromuscular blocking agent medically** **Verify correct electrode placement** **Verify stimulation**

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ENoG Recording: Trouble Shooting

Symptom:	**Poor response bilaterally**
Problems:	**Edema at stimulation side (in trauma)**
	Tenderness/pain precludes adequate stimulus electrode pressure
Solutions:	**Pain relief**
	Defer recording to later time

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ENoG Recording: Trouble Shooting

Symptom:	**Poor response bilaterally**
Problems:	**Obese patient**
	Ineffective stimulation
	Bilateral dysfunction or injury
Solutions:	**Apply pressure to stimulating electrodes**
	Needle electrodes
	Compare patient ENoG amplitudes to normal data

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ENoG Recording: Trouble Shooting

Symptom:	**Excessive artifact rejection (cannot average)**
Problems:	**Stimulus artifact**
	Very large normal response
Solutions:	**Increase distance btw stim & recording electrodes**
	Avoid crossing stim/rec electrode wires
	Use post-stimulus delay
	Decrease amplification (gain)

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ENoG Recording: Trouble Shooting

Symptom: Early response (peak before 6 ms)

Problem: Masseter muscle response

Solution: Move stimulating electrode posteriorly

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Review Questions

Who introduced electroneuronography as a clinical procedure, and coined the term:

a. Hallowell Davis
b. James Jerger
c. Robert Galambos
d. Ugo Fisch
e. Derrald Brackmann

Review Questions

Which of the following diseases is associated with facial paralysis?

a. Herpes zoster
b. Guillain Barre syndrome
c. Temporal bone fracture
d. Bell's palsy
e. All of the above

Review Questions

The facial nerve exits the skull at the:

a. Internal auditory canal
b. Foramen magnum
c. Stylomastoid foramen
d. Facial canal
e. Gerhardt's passageway

Review Questions

The facial nerve is a purely motor nerve:

a. True
b. False

Review Questions

The term describing total severing of the facial nerve is:

a. Neuropraxia
b. Neurotmesis
c. Axontmesis
d. Discontinuity
e. Paralysis

Review Questions

Diabetics are more likely to develop Bell's palsy than non-diabetics:

a. True
b. False

Review Questions

The best time frame for ENoG measurement and clinical value is:

a. Immediately upon injury
b. Within 24 hours of onset of facial nerve dysfunction
c. 72 hours after onset
d. 21 days after onset
e. Any of the above times are O.K.

Review Questions

The facial nerve exits the skull at the:

a. Internal auditory canal
b. Foramen magnum
c. Stylomastoid foramen
d. Facial canal
e. Gerhardt's passageway

Review Questions

A typical stimulus in ENoG recording is:

a. 80 dB HL
b. 20 microvolts
c. 20 amps
d. 20 mA
e. 50 mA

Review Questions

Grade 6 on the HB scale is:

a. Normal facial nerve function
b. No eye blink
c. Ocular tremor
d. Asymmetric smile
e. Total facial paralysis

Review Questions

Which of the following pathological processes is measured in ENoG recording:

a. Temporal bone fracture
b. Bell's palsy
c. Auditory-facial neuropathy (ANF)
d. Wallerian degeneration
e. Sensory facial nerve activation

Review Questions

The stimulating electrode and location is best described by which of the following:

a. Anode anterior and cathode posterior
b. Negative anterior and positive posterior
c. Naso-labial fold
d. Anode posterior and cathode anterior
e. “Black” anterior and “red” posterior

Review Questions

The optimal stimulus intensity level for ENoG recording is:

a. > 95 dB nHL
b. > 40 mA
c. 20 to 40 mA
d. Supra-maximal intensity level
e. Level producing facial nerve twitching

Review Questions

Recording electrodes in ENoG measurement are placed at the:

a. Fz and SMF locations
b. Stylomastoid foramen
c. Forehead and corner of eye
d. Nasolabial fold
e. Corner of mouth and eye

Review Questions

A significant abnormality in ENoG recording is defined as:

a. Amplitude of 20 microvolts
b. Involved to non-involved ratio of 40%
c. Degeneration of > 50% for involved vs. non-involved side
d. Degeneration of > 90% for involved vs. non-involved side
e. None of the above

Review Questions

A peak in an ENoG recording less than 6 ms is probably:

a. PAM artifact
b. Wave P1
c. Sternocleidomastoid muscle
d. Masseter muscle
e. Buccal muscle